NYU General Physics 1—Problem set 2

Problem 1: What is the mean acceleration $a$ of a dragster (that is, a drag-racing automobile) that can travel 0.25 mi in 5.5 s, starting from a dead stop? Assume that the dragster accelerates with constant acceleration throughout the 5.5 s (not a terrible assumption, but not a good one either). Give your answer in terms of the gravitational acceleration $g$. Does your answer seem reasonable? What do you predict, under the constant-acceleration assumption, for the final speed $v_f$ of the dragster as it crosses the finish line? Convert your answer to mi h$^{-1}$. Search the web for the current world-record quarter-mile drag-race time and final speed.

Problem 2: For the time interval $0 < t < 1$ s, draw graphs of the vertical position $y$ (height) as a function of time, the vertical velocity $v_y$ as a function of time, and the vertical acceleration $a_y$ as a function of time of a rock that is thrown precisely upwards at $3$ m s$^{-1}$ at time $t = 0$. For definiteness, set $|\vec{g}| = 10$ m s$^{-2}$ and make the “upwards” direction the positive-$y$ direction. Where does the rock “end up” at the end of the 1 s period; that is, what is $y(1\text{ s})$? Assume that the rock is large and dense enough that we can ignore air resistance.

Problem 3: Below is a graph of velocity $v_x$ in the $x$ direction as a function of time $t$. Draw the corresponding graph of position $x$ vs time $t$ and acceleration $a_x$ vs time $t$. Be very careful with the transitions and the vertical scales.